Sleep Health 1 (2015) 233–243

Contents lists available at ScienceDirect

Sleep Health

Journal of the National Sleep Foundation

journal homepage: http://www.elsevier.com/locate/sleh

National Sleep Foundation's updated sleep duration recommendations: final report☆

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ARTICLE INFO

Article history:
Received 1 October 2015
Received in revised form 6 October 2015
Accepted 6 October 2015

Keywords:
National Sleep Foundation
Sleep sufficiency
Sleep adequacy
Sleep by age
Life span sleep
RAND/UCLA Appropriateness Method
Sleep need
Sleep time recommendations
Sleep duration

ABSTRACT

Objective: To make scientifically sound and practical recommendations for daily sleep duration across the life span.
Methods: The National Sleep Foundation convened a multidisciplinary expert panel ("Panel") with broad representation from leading stakeholder organizations. The Panel evaluated the latest scientific evidence and participated in a formal consensus and voting process. Then, the RAND/UCLA Appropriateness Method was used to formulate sleep duration recommendations.
Results: The Panel made sleep duration recommendations for 9 age groups. Sleep duration ranges, expressed as hours of sleep per day, were designated as *recommended*, *may be appropriate*, or *not recommended*. Recommended sleep durations are as follows: 14-17 hours for newborns, 12-15 hours for infants, 11-14 hours for toddlers, 10-13 hours for preschoolers, 9-11 hours for school-aged children, and 8-10 hours for teenagers. Seven to 9 hours is recommended for young adults and adults, and 7-8 hours of sleep is recommended for older adults. The self-designated basis for duration selection and critical discussions are also provided.
Conclusions: Consensus for sleep duration recommendations was reached for specific age groupings. Consensus using a multidisciplinary expert Panel lends robust credibility to the results. Finally, limitations and caveats of these recommendations are discussed.

☆ Endorsed by the National Sleep Foundation, American Association of Anatomists, American Congress of Obstetricians and Gynecologists, American Geriatrics Society, American Physiological Society, American Thoracic Society, Gerontological Society of America, Human Anatomy and Physiology Society, and Society for Research in Human Development.

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http://dx.doi.org/10.1016/j.sleh.2015.10.004
2352-7218/

Introduction

The question "How much sleep do we need?" is a natural and relevant question, especially for parents of children and teens and for those who care for aging parents. Sleep represents an essential element for health and well-being, including cognitive performance, physiological processes, emotion regulation, physical development, and quality of life. Appropriate sleep duration ranges vary throughout the life span. Currently, no easily accessible, validated method for individuals to measure their sleep exists. Therefore, the public and practitioners must rely on bedtime duration as a surrogate. Consequently, the National Sleep Foundation (NSF) has committed to regularly update its sleep duration recommendations to provide the public up-to-date, scientifically sound information. Unfortunately, the nature and quantity of published work precluded conducting a standard evidence-based medicine meta-analysis for each age grouping. Therefore, a multidisciplinary expert panel ("Panel") was convened by NSF to review, discuss, and interpret extant literature.

The purpose of the present article is to provide additional information on the conversations transcribed from the Panel's discussions and appropriateness voting. In addition, the basis by which Panel members made decisions and the issues deemed important to specific age groups are reviewed. Given the breadth of available information on the subject, citations are not provided throughout the paper. Instead, Table 1 catalogs the articles that were given to the panel for consideration during their discussions.

Participants and methods

The methodological details used to produce the sleep duration recommendations appear in Hirshkowitz and colleagues.[1] But a brief summary is provided here.

An 18-member multidisciplinary expert Panel, comprised of sleep researchers, physicians, and experts in other areas of medicine, physiology, and science, was assembled by the NSF. Twelve representatives selected by stakeholder organizations and 6 sleep experts appointed by the NSF were included on the Panel. Organizations that sent representatives included the following: American Academy of Pediatrics, American Association of Anatomists, American College of Chest Physicians, American Congress of Obstetricians and Gynecologists, American Geriatrics Society, American Neurological Association, American Physiological Society, American Psychiatric Association, American Thoracic Society, Gerontological Society of America, Human Anatomy and Physiology Society, and the Society for Research in Human Development. A rigorous consensus process, which included evaluation of a systematic literature review and participation in 2 rounds of consensus voting, was undertaken by the Panel.[1]

A systematic literature review identified 312 articles that met all criteria. All studies appeared in the literature within the past 10 years, and the population had to be described as a normal population (ie, nondisordered). Table 1 lists all articles in the review.

The Panel used the RAND/UCLA Appropriateness Method, a 2-round modified Delphi process,[2] for the development of the sleep duration recommendations. Every sleep time duration from 0 to 24 hours was evaluated for appropriateness. Response options were **inappropriate**, scores ranging from 1 to 3; **uncertain**, scores ranging from 4 to 6; or **appropriate**, scores ranging from 7 to 9. Appropriateness for overall health and well-being, as well as cognitive, physical, and emotional health, was rated by the Panel. Panelists also noted whether their voting was based on: (*a*) convincing scientific evidence; (*b*) weaker scientific evidence; (*c*) expert opinion; or (*d*) their own experience. The Panel members cast independent votes during 2 rounds of formal consensus voting. Round 1 votes were cast individually. The second vote occurred immediately following discussion and debate about each age group during an in-person meeting. When possible, the Panel reached consensus. However, no effort was made to eliminate disagreement.

Sleep duration recommendations were formulated using the median appropriateness scores and were classified as one of the following:

- Appropriate: scores ranging from 7 to 9, with agreement.
- May be appropriate for some people: a score ≥4, with disagreement.
- Unlikely to be appropriate: a score ≤3, with agreement.

Results

Figure 1 illustrates the Panel's recommendations for sleep. Recommended durations, expressed in hours per day, are shown.

The recommendations consider overall health and well-being, as well as cognitive, emotional, and physical health. Information relating to each age grouping along with the Panel's considerations and caveats appear below.

Newborns: 0-3 months

Overall health and well-being, as well as cognitive, emotional, and physical health, were considered when voting on appropriate sleep durations for newborns. The Panel recommends a 14- to 17-hour sleep duration for newborns. Weaker scientific evidence and the experts' own experience and/or opinion form the basis for the Panel's recommendations. There was not enough scientific evidence to distinguish differences between cognitive, physical, and emotional health. Therefore, for newborns, experts only voted on appropriate sleep duration for overall health, with the understanding that this includes components of cognitive, physical, and emotional health. The medical and scientific literature varies considerably with respect to the sleep needs of newborns, with little evidence assessing short sleep duration consequences in this age range. These factors contributed to the wide dispersion of recommended sleep durations for newborns. In addition, most studies use subjective data (eg, parent interviews or questionnaires) rather than objective measures (eg, actigraphy or polysomnography) to quantify normative values for newborn sleep. No studies assess risks associated with long sleep in newborns. However, the Panel expressed concern that regularly sleeping longer than 19 hours may limit a newborn's environmental interaction and may impede cognitive and/or emotional development.

Sleep duration recommendations for newborns may not apply during the first few days of life because long sleep can be normal. Rapid maturational changes in sleep patterns occur in newborns, and appropriate sleep durations may vary widely based on actual age. During the first few days of life, greater than 18 hours of daily sleep may be appropriate. For a 3-month-old, however, this sleep duration may be considered long.

Infants: 4-11 months

Overall health and well-being, as well as cognitive, emotional, and physical health, were considered when voting on appropriate sleep durations for infants. Twelve to 15 hours of sleep per day is recommended for infants by the Panel. Rapid maturational changes occur during infancy; therefore, appropriate sleep durations can vary widely based on actual age. For example, a 4-month-old may require more sleep than an 11-month-old. Results indicated that the experts believed that slightly longer sleep durations might be needed for different components of health. Sleep duration recommendations for infants are based primarily on weaker scientific evidence and the Panel members' own experience and/or opinion.

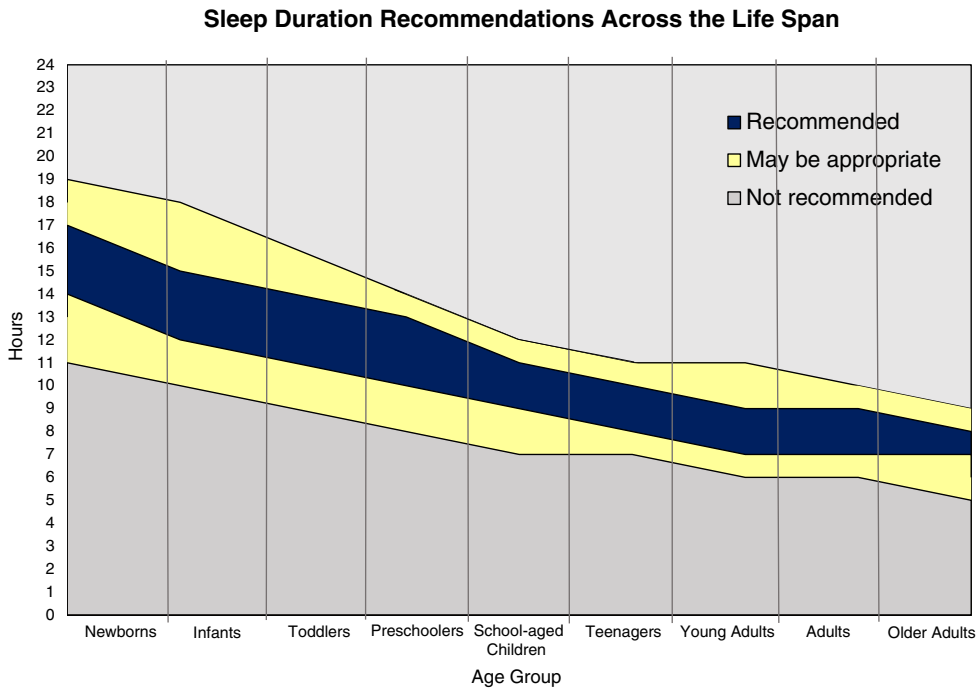

Fig. 1. Sleep duration recommendations across the life span.

Limited evidence suggests an association between short sleep duration and abnormal physical growth and obesity. As with newborns, no studies assess the risks associated with long sleep durations in infants. Long sleep durations could limit an infant's environmental interaction that might impede cognitive development, emotional development, or both, according to the Panel. Clinical evaluation of long sleep duration in infants is recommended by the Panel because long sleep duration may signal a physical and/or mental health condition.

Toddlers: 1-2 years

Overall health and well-being, as well as cognitive, emotional, and physical health, were considered when voting on appropriate sleep durations for toddlers. Eleven to 14 hours of sleep per day is recommended for toddlers by the Panel. Experiential studies reveal an association between short sleep duration, obesity, hyperactivity-impulsivity, and lower cognitive functioning. Results revealed that the Panel believed that slightly longer sleep durations might benefit toddlers' emotional health. These sleep duration recommendations were based primarily on some convincing evidence, weaker scientific evidence, and the Panel members' own experience and/or opinion.

Long sleep duration could interfere with toddlers' exploration of their physical and social environment and thereby impede motor, cognitive, and social development, according to the Panel.

Preschooler: 3-5 years

Overall health and well-being, as well as cognitive, emotional, and physical health, were considered when voting on appropriate sleep durations for preschoolers. Ten to 13 hours of sleep per day is recommended for preschoolers by the Panel. Results revealed that the experts believed that slightly shorter sleep durations might be sufficient for physical and emotional health. These recommendations were derived primarily from both convincing and weaker scientific evidence. To a lesser extent, the Panel formed their opinion from their own experience. More convincing published evidence exists for the preschooler age group compared with the younger age groups. This generated greater agreement among the Panel members.

Published associations between long naps, detriments in cognition, later nighttime sleep onset, and shorter nighttime sleep duration in preschoolers were discussed by the Panel. Evidence showing that preschoolers who slept less than 9 hours per night have greater odds of being obese than those sleeping 10 or more was considered.

School-age: 6-13 years

Overall health and well-being, as well as cognitive, emotional, and physical health, were considered when voting on appropriate sleep durations for school-aged children. Nine to 11 hours of sleep per day is recommended for school-aged children by the Panel. Results were consistent between all components of health. Scientific evidence, some strong and some weak, was predominantly the basis of the Panels' recommendations. A much larger knowledgebase exists in published literature for this group than for younger groups. Research indicating associations between short sleep in school-aged children and lower cognitive functioning and poorer academic performance largely informed the Panel when forming their recommendations.

In addition to age, pubertal maturation is a potential milestone for recommended sleep duration. A postpubertal adolescent typically sleeps less than a younger prepubertal school-aged child. However, evidence also reveals that when sleep extension is available, sleep duration increases in postpubertal adolescents. In addition, cognitive and academic performance improves.

Teenagers: 14-17 years

Overall health and well-being, as well as cognitive, emotional, and physical health, were considered when voting on appropriate sleep durations for teenagers. Eight to 10 hours of sleep per day is recommended for teenagers by the Panel. Results were consistent between all components of health. Recommendations for teenagers primarily came from convincing and weaker scientific evidence.

Literature concerning early school-start times and how they mediate sleep deprivation in teenagers, particularly for evening chronotypes, was considered. There was concern about short sleep duration in teenagers potentially leading to decreased alertness, automobile accidents, depressed mood, obesity, poor health, and low academic performance. Interventional research shows that delaying school-start times approximately 1 hour later increases students' sleep duration and decreases daytime sleepiness.

Young adult: 18-25 years

Overall health and well-being, as well as cognitive, emotional, and physical health, were considered when voting on appropriate sleep durations for young adults. Seven to 9 hours of sleep per day is recommended for young adults by the Panel. Results were consistent between all components of health. Both convincing scientific evidence and weaker scientific evidence support this recommendation. The Panel spent considerable time discussing the heterogeneity in this age group. Teenagers represent a mixed group for sleep patterns due to differences related to responsibilities, school, work, and social life. Sleep in young adults who enter the workforce differs markedly from college students, who suddenly have reduced parental supervision, rigorous studies, and many new social opportunities.

The Panel does not advocate sacrificing sleep duration for school, work, or social responsibilities because short sleep duration is associated with increased fatigue, decreased psychomotor performance, accidents, poor physical and psychological health, and low academic performance. In addition, healthy sleep patterns enhance adjustment and performance in college years; early bedtimes, wake times, and napping correlate with the high academic performance. Finally, extended sleep leads to substantial improvements in daytime alertness, reaction time, and mood.

Adult: 26-64 years

Overall health and well-being, as well as cognitive, emotional, and physical health, were considered when voting on appropriate sleep durations for adults. Seven to 9 hours of sleep per day is recommended for adults by the Panel. Results indicate that the Panel believed that slightly shorter sleep durations might be sufficient for emotional health. Both convincing and weaker scientific evidence for adults informed the Panels' recommendations. The Panel recognized that sleep deprivation is widespread and increasing in the adult population. Restricted sleep time particularly affects 45- to 54-year-olds, the age range when time at work usually reaches its maximum in the life span. Sleep deprivation's adverse effect on multitasking performance, weight regulation, job safety, mental health, sugar regulation, blood pressure, and cardiovascular health was noted, particularly with nighttime sleep deprivation during the workweek.

Older adult: ≥65 years

Overall health and well-being, as well as cognitive, emotional, and physical health, were considered when voting on appropriate sleep durations for older adults. Seven to 8 hours of sleep per day is recommended for older adults by the Panel. Results were consistent between all components of health. Recommendations for older adults were primarily based on both convincing and weaker scientific evidence. Reduced total sleep duration and sleep fragmentation in older adults were discussed by the Panel. In general, most retired older adults have decreased or no employment-related responsibilities and less obligatory sleep schedule demands. Moreover, older adults have more opportunities to sleep compared with younger adults; older adults often nap. How age-associated morbidities influence sleep in older adults was discussed by the Panel. Regardless of sleep changes in older adults, sleep need changes little compared with younger adults.

Other considerations included findings that older adults sleeping 6-9 hours have better cognitive functioning, lower rates of mental and physical illnesses, and enhanced quality of life compared with shorter or longer sleep durations. However, considerable evidence shows that long sleep duration (≥9-10 hours) in older adults is associated with morbidity (eg, hypertension, diabetes, atrial fibrillation, poor general health) and mortality. Excessive sleep may be a marker in older adults signaling the need for medical, neurological, or psychiatric evaluation.

Daytime napping is perceived as common, but not universal, in older adults. However, older adults report more daytime sleepiness than younger adults. Overall, the literature contains conflicting reports concerning napping's association with morbidity in older adults.

Discussion

This analysis considered extant scientific literature, medical literature, and the Panel's own professional experience. Their interpretation of these data sources produced consensus recommendations for sleep time duration recommendations for each age group. Consequently, the NSF updated its recommendations for sleep durations across the life span.

The "possibly acceptable" range underscores considerable individual variability in sleep durations. The Panel emphasizes that some individuals might sleep on the low or high end of these ranges with no adverse effects. However, sleep duration represents only one sleep dimension; other sleep features such as sleep depth, quality, and timing also characterize overall sleep health. Nonetheless, the Panel believes that minimum and maximum sleep durations exist in each age group. Sleep durations far outside the normal range should raise concern. Excess or restricted sleep duration may produce or result from serious problems that affect health and well-being.

Sleep, like diet and exercise, strongly influences many aspects of health including physical, cognitive, and emotional health. Although most individuals' sleep duration falls within the "recommended" range, individuals and their physicians should carefully consider cognitive, physical, and emotional health when sleep durations do not. The variation may merely represent differences in sleep need. However, prudence dictates considering health problems as both potential causes and consequences. Sleep restriction may predispose a person to adverse health conditions. By contrast, atypically increased sleep duration may suggest compensation for diminished sleep depth and/or quality. Thus, when no overall health condition accompanies individuals getting a nonrecommended sleep amount, one ought to consider risk assessments for cognitive, physical, or emotional health problems. Finally, individuals with daily sleep duration far outside of the recommended range need serious assessment. If the individual purposefully restricts his or her sleep, they may benefit from education concerning sleep deprivation's potential health, social, and legal consequences.

This work has limitations. The strongest evidence, according to evidence-based medicine criteria, derives from large cohort studies. Sleep data from these studies characteristically involve self-report. Thus, few reports include objective measures. In addition, actuarial data describe total bedtime rather than sleep time and do not consider pathology. Interpreting such evidence requires weighing it against data from correlational studies and smaller sample interventional trials designed to expose altered sleep duration's association with problems or illness. Sleep deprivation studies may convincingly attribute cause for performance failure or fatigue. But cohort and correlational studies mainly show association. In different age groups, different evidence exists. Researchers often favor different yardsticks depending

on age–for example, developmental milestones for infants, academic performance for school-aged children, social adjustment for teens, employment and social-relationship success in adults, and morbidity and mortality for older adults. This nonuniformity in the medical and scientific literature makes interpretation difficult and traditional meta-analysis problematic when attempting to uniformly provide sleep duration recommendations across age groups. Therefore, the RAND Appropriateness Method[2] was used to systematically provide answers. Although expert consensus conclusions are imperfect, using an interdisciplinary Panel represents a powerful technique for providing the best available information. Furthermore, including experts from scientific and clinical areas outside the "sleep field" provides a varied, balanced perspective and ultimately strengthens the conclusions. Clearly, we need further research to improve our understanding of sleep, and our sleep duration recommendations will undergo successive refinement over time. Research areas needing particular attention encountered during this project include: long sleep durations' association with health across the life span; gender-specific pubertal and menopausal sleep duration alterations; and the interplay between napping, nighttime sleep, and health, particularly in older adults.

In conclusion, the present project established recommendations for sleep durations across the life span. National Sleep Foundation's guidance includes recommended ranges of sleep duration across the life span. These recommendations focus on overall health and well-being and provide important basic information for improving sleep health.

Acknowledgments

Literature review team: John Herman, PhD; David Brown, PhD; and Chelsea Vaughn, PhD.

Research assistants: Jenna Faulkner, Luca Calzoni, Ben Getchell, and Taylor Nelson.

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Table 1
List of articles in literature review.

Newborn sleep (0-3 mo)
Hiscock, *Archives of Diseases in Childhood*, 2011, http://dx.doi.org/10.1136/adc.2010.204925
Jenni, *Pediatrics*, 2007, pmid: 17908734
Komada, *Sleep Medicine*, 2012, http://dx.doi.org/10.1016/j.sleep.2011.10.017
Mindell, *Sleep Medicine*, 2010, http://dx.doi.org/10.1016/j.sleep.2009.04.012
Mindell, *Sleep Medicine*, 2009, http://dx.doi.org/10.1016/j.sleep.2008.07.016
Price, *Archives of Diseases in Childhood*, 2014, http://dx.doi.org/10.1136/archdischild-2013-304150
Sadeh, *Journal of Sleep Research*, 2009, http://dx.doi.org/10.1111/j.1365-2869.2008.00699.x
So, *Journal of Sleep Research*, 2007, pmid: 17542948
Teng, *Journal of Paediatrics and Child Health*, 2012, http://dx.doi.org/10.1111/j.1440-1754.2011.02251.x
Tikotzky, *Child Development*, 2009, http://dx.doi.org/10.1111/j.1467-8624.2009.01302.x
Tikotzky, *Journal of Sleep Research*, 2010, http://dx.doi.org/10.1111/j.1365-2869.2009.00772.x
Williams, *JAMA Pediatrics*, 2013, http://dx.doi.org/10.1001/jamapediatrics.2013.423
Infant sleep (4-11 mo)
Blair, *Sleep*, 2012, http://dx.doi.org/10.5665/sleep.1694
Hiscock, *Archives of Diseases in Childhood*, 2011, http://dx.doi.org/10.1136/adc.2010.204925
Jenni, *Pediatrics*, 2007, pmid: 17908734
Klingenberg, *Pediatric Obesity*, 2012, http://dx.doi.org/10.1111/j.2047-6310.2012.00109.x
Komada, *Sleep Medicine*, 2012, http://dx.doi.org/10.1016/j.sleep.2011.10.017
Lampl, *Sleep*, 2011, pmid: 21532958
Mindell, *Sleep Medicine*, 2010, http://dx.doi.org/10.1016/j.sleep.2009.04.012
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Sadeh, *Journal of Sleep Research*, 2009, http://dx.doi.org/10.1111/j.1365-2869.2008.00699.x
Scher, *Early Human Development*, 2005, pmid: 15814211
So, *Journal of Sleep Research*, 2007, pmid: 17542948
Taveras, *Archives of Pediatrics and Adolescent Medicine*, 2008, http://dx.doi.org/10.1001/archpedi.162.4.305
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Tikotzky, *Sleep Medicine*, 2012, http://dx.doi.org/10.1016/j.sleep.2011.07.013
Touchette, *Archives of Pediatric and Adolescent Medicine*, 2005, pmid: 15753267
Williams, *JAMA Pediatrics*, 2013, http://dx.doi.org/10.1001/jamapediatrics.2013.423
Toddler sleep (1-2 y)
Acebo, *Sleep*, 2005, pmid: 16408417
Aishworiya, *ANNALS Academy of Medicine Singapore*, 2012, pmid: 22538736
Bernier, *Child Development*, 2013, http://dx.doi.org/10.1111/cdev.12063
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